PATENT SPECIFICATION

DRAWINGS ATTACHED

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Int. Cl.:—**H 05 k 7/02//B 29 d, H 01 f**

COMPLETE SPECIFICATION

Encapsulated Electrical Devices and Methods of Manufacturing Such Devices

We, CONSOLIDATED ELECTRODYNAMICS CORPORATION, a corporation organised and existing under the laws of the State of California, United States of America, of 360 N. Sierra Madre Villa, Pasadena, California, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to encapsulated electrical devices and to a method of manufacturing such devices, and more particularly, to such devices which are suitable for use in amplifiers arranged to amplify an electrical input signal to a level suitable to function with a process control instrument such as a recorder or indicator.

In many instances such amplifiers are operated in areas subjected to corrosive atmospheric conditions, dust, and moisture, and consequently it is desirable that the electronic components of the amplifier be protected against such adverse elements by hermetically sealing the components within a casing. Moreover, it is desirable that the encapsulated units of the amplifier be readily interconnectable to provide for assembly of the amplifier and the servicing and replacement of the encapsulated units in the field. Moreover, it is desirable that the various encapsulated electronic units going into an amplifier may be readily connected in the desired circuit arrangement.

In many process control applications, it becomes necessary to calibrate the instrument amplifier so that it may be used with measuring units having different spans and having different zero calibration points. For example, under certain conditions an instrument amplifier may be called upon to produce an output signal which varies over a given range of, for example, from 0.4 volts to 2.0 volts when the process temperature varies from 30°C. to 40°C., i.e., a span of 10°C. This means that the amplifier must produce its minimum output signal of 0.4 volts when the measuring thermocouple is producing a predetermined electrical signal at 30°C. and should produce its maximum output signal of 2.0 volts when the thermocouple is producing a different electrical signal at 40°C. On the other hand, the amplifier may under other conditions be called upon to produce an output signal range of from 0.4 volts to 2.0 volts in response to a temperature variation of from 30°C. to 100°C. Under these latter conditions the input span is 70°C. whereas under the first set of conditions the input span was 10°C. Also, it is necessary in many instances to vary the zero calibration point of the amplifier. Thus, it may be desirable to measure a ten-degree span starting with 0°C. in one instance whereas it is desirable to measure a ten-degree centrigrade span starting from 100°C. in another application. Span calibration and zero or offset calibration may readily be accomplished inductively by simply varying the number of turns on respective windings of a transformer.

It is desirable in such an instrument amplifier that the span and zero offset points be readily variable in the field; i.e., the encapsulated electrical units must readily be adapted for various field applications by the mere inductive variance of the number of turns of a transformer winding. However, difficulty may be experienced when varying the number of turns of an encapsulated transformer.

According to one aspect of the invention, there is provided an encapsulated electrical

unit, comprising an assembly of electrical components including at least one winding of a transformer, a compound encapsulating said components into a sealed unit, and a plurality of electrical terminals accessible from the exterior of the encapsulated unit and connected to selected one of said components, at least two of said terminals being adapted to receive a further winding for said transformer, said unit being provided with a passageway extending through the inductive circuit of said one winding to provide for the winding of a selected number of turns of wire forming said further winding.

According to another aspect of the invention, there is provided a method of forming an encapsulated electrical unit, comprising the steps of mounting an assembly of electrical components including at least one winding of a transformer on a mounting panel, placing said mounting panel with said electrical components thereon in a mould including at least one member positioned to extend through the inductive circuit of said one winding of said transformer, admitting encapsulating compound into said mould to encapsulate said components so as to form the encapsulated electrical unit, and removing said mould and said member from said encapsulated electrical unit, whereby the encapsulated electrical unit has a passageway formed through the inductive circuit of said one winding by the presence of the said member during the encapsulating step, which passageway permits the winding of turns of wire forming a further winding for the transformer.

Thus, in accordance with the present invention, the electrical or electronic circuit of an instrument amplifier is encapsulated in units which are readily interconnectable by a plurality of printed circuit type electrical connectors. The electrical components are provided with terminals which align with cooperating conductors of a printed circuit type connector to provide the circuit connections to and between the encapsulated electronic units of the amplifier.

In one method according to this invention a printed circuit board carrying the electrical or electronic components is supported in the pouring mould by means of the electrical terminals which serve the dual functions of both spacing and supporting the printed circuit board and electronic components from the mould during the moulding operation and additionally serve to provide electrical connections to the completed encapsulated electronic unit. The end surfaces of the electrical terminals are secured against the surface of the pouring moulds so that they are not covered by encapsulating material. In one embodiment of the present invention, where it is desired to encapsulate one winding of a transformer while permitting the second winding of the transformer to be wound after an encapsulation of the electronic components, certain of the components, terminal members, and electronic devices are first cast in place in a container of encapsulating material, suitable openings being provided adjacent the transformer windings to provide for the later winding of the transformer secondaries. These components, along with various additional components, such as electronic components assembled on a printed circuit board provided with electrical terminals are then assembled as a unit in a pouring mould and the entire sub-assembly is then further encapsulated with additional moulding material. Projections are provided on the moulds which extend through the transformer windings to provide passageways through the windings for the subsequent winding of the transformer secondaries.

In order that the invention can be fully understood some embodiments thereof will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of an instrument amplifier formed of a plurality of encapsulated electrical units;

Fig. 2 is a perspective view of a printed circuit board and component assembly for one of the encapsulated electrical units of Fig. 1;

Fig. 3 is a cross-sectional view of an electrical terminal of the assembly of Fig. 2, taken along line 3—3 of Fig. 2;

Fig. 4 is a perspective view illustrating the assembly of Fig. 2 positioned on a surface of a casting mould as one step of the encapsulating process;

Fig. 5 is a cross-sectional view illustrating the fastening of an electrical terminal of the assembly of Fig. 2 to the casting mould, taken along line 5—5 of Fig. 4;

Fig. 6 is a top view of the encapsulating mould for encapsulating the assembly of Fig. 2;

Fig. 7 is a broken away side elevational view of the casting mould of Fig. 6 illustrating the circuit board and component assembly positioned within the mould;

Fig. 8 is a front elevational view of the pouring mould of Fig. 7;

Fig. 9 is a top view illustrating a plurality of electrical components secured to a casting mould prior to encapsulation in accordance with the present invention;

Fig. 10 is a broken-away side view of the mould and components of Fig. 9;

Fig. 11 is a sectional front view of the mould and component assembly of Fig. 9, taken along line 11—11 of Fig. 9;

Fig. 12 is a perspective view of the partially encapsulated components as provided by the mould of Fig. 9;

Fig. 13 is a perspective view of an electronic assembly including the partially encapsulated components of Fig. 12, and additionally in-

cluding a printed circuit board and electrical component assembly;

Fig. 14 is a side elevational view illustrating the assembly of Fig. 13 positioned within a casting mould during one step of an encapsulating process;

Fig. 15 is a front elevational view of the mould of Fig. 14;

Fig. 16 is a cross-sectional bottom view of the mould and component assembly of Figs. 14 and 15, taken along line 16—16 of Fig. 15;

Fig. 17 is a perspective view of an encapsulated electrical unit as produced by the moulding process of Figs. 9 to 16 and illustrating the manner in which winding of the span and the offset transformer is accomplished;

Fig. 18 is a perspective view of the encapsulated electrical unit of Fig. 17 but illustrating a different turns ratio for one of the transformers thereof;

Fig. 19 is a cross-sectional view of the encapsulated electrical unit of Fig. 18, taken through one of the transformers thereof along line 19—19 of Fig. 18;

Fig. 20 is a fragmentary sectional view illustrating a connection between an encapsulated electrical unit and a printed circuit type electrical connector;

Fig. 21 is a perspective view of a printed circuit type electrical cable for connecting adjacent encapsulated units;

Fig. 22 is a partial sectional view of the cable of Fig. 21 taken along the line 22—22 of Fig. 21;

Fig. 23 is a fragmentary cross-sectional view illustrating a modified form of connection between an electrical cable connector and encapsulated unit according to the present invention; and

Fig. 24 is a cross-sectional view illustrating another modified form of connection between an electrical cable connector and encapsulated unit according to the present invention.

Referring now to the drawings, there is illustrated in Fig. 1 an encapsulated unit rack assembly 20 including a pair of angle-shaped frame members 21 and 22 supporting a plurality of encapsulated electrical devices or units 23, 24 and 25. This unit rack assembly 20 may comprise the component modules of an instrument amplifier. For example, the first encapsulated electrical or electronic unit 23 contains electronic components wired to form an input comparison module and other encapsulated electronic units 24 and 25 comprise other modules of the amplifier. It will be understood that an input signal is developed by a primary measuring element such as a thermocouple and is supplied to input terminals 26, 27 of the input comparison module 23 and the output signal from the encapsulated unit rack assembly 20 is connected to a recording arrangement.

The encapsulated units 23, 24 and 25 are electrically interconnected by a flexible printed-circuit type cable or connector 30 which, as illustrated in Figs. 21 and 22, includes a plurality of electrical conductors 31 laminated between a pair of insulating sheets 32 and 33 which may be of Teflon (Trade Mark) or similar plastic material, and provided with enlarged contact portions 34 aligned with various electrical terminals of the encapsulated units 23, 24 and 25. A plurality of contact screws 35 electrically connect the conductors 31 at the contact portions 34 with various electrical terminals of the encapsulated units 23, 24 and 25 so as to interconnect the units into the desired circuit.

Figs. 2 to 8 illustrate the steps of encapsulating the unit 24 (Fig. 1) which may comprise one of the modules of an instrument amplifier. The encapsulated unit 24 includes an electronic board assembly 37 of the printed circuit type mounting a plurality of electronic components 40 e.g. capacitors 40*a*, resistors 40*b*, transistors 40*c*, which are mounted on a panel 41 of insulating material which may contain on one or both sides thereof a plurality of conducting lead elements 42, Fig. 5, as is well known in the formation of printed circuits. A plurality of knurled studs 43 which also serve as electrical terminals are secured to one side of the mounting panel 41 by attaching the same to the conducting elements 42 by soldering or any other suitable manner. The electronic components 40*a*, 40*b* and 40*c* are electrically connected to the electrical terminals 43, preferably through the conducting lead elements 42. Electronic components may be mounted on one or both sides of the panel 41, as hereinafter more fully illustrated in connection with another embodiment. Each of the electrical terminals 43 is generally cylindrical, is provided with serrations 44 on its outer surface and has a planar end surface 45. Moreover, each of the electrical terminals 43 is provided with suitable fastening means for connection to an external electrical member such as the contact screws 35, and accordingly, as herein illustrated, is provided with internal threads 46.

In order accurately to position the electronic board assembly 37 during the encapsulating process and to space the supported electronic components from the sides of the mould, the assembly 37 is mounted on a mould plate 47 by a plurality of aligning screws 50 which pass through openings 51, Fig. 5, in the mould plate 47 aligned with the electrical terminals 43 and are threaded into the internal threads 46 thereof. The aligning screws 50 are of suitable length to grip firmly the respective electrical terminals and to draw the planar end surfaces 45 of their respective terminals 43 tightly against the mould plate 47 so as to prevent coating of the end surfaces 45

with the encapsulating compound when the mould is poured.

In order to provide a housing for the moulding compound, the mould plate 47 forms one part or closure of a die 52 which additionally includes a two-piece box-shaped die portion 53 which separates along a parting line 54 to provide for removal of the moulded unit. A pair of aligning pins 55 and 56 position the two pieces of the box-shaped die portion 53 in proper relation and the die portion 53 is provided with a groove 57 for receiving and accurately aligning and positioning the mould plate 47. The die 52 forms the casting cavity 60, Fig. 7, and the mould plate 47 is effective accurately to position the electronic board assembly 37 within the casting cavity. A sprue opening 61 is provided in the die portion 53 to provide for filling the cavity 60 with a casting compound. The mould plate 47 or other portions of the die 52 may be provided with recesses 62 or the like to provide for casting or mouding of aligning surfaces and the like in the encapsulated units.

In order to encapsulate the electronic board assembly 37, the cavity 60 in the die 52 is filled with a compound such as a polyester resin containing a mineral filler such as ground silica powder, and containing a setting or hardening agent. The moulding compound is poured through the sprue opening 61 to surround the electronic board assembly 37. Such an encapsulating material may be poured at room temperature and has a low surface tension so that it readily pours under gravity only. The filler provides for strength and reduces the shrinkage of the casting compound during the setting thereof. Once of the encapsulating compound has hardened in the die 52, the die 52 can readily be separated along the parting lines 54 to expose the encapsulated unit secured to the mould plate 47, by the screws 50. The screws 50 are then removed to release the encapsulated unit. It will be appreciated that the encapsulated unit is provided with clean contact end surfaces 45 on the electrical terminals 43 due to their engagement with the mould plate 47. Such a unit may then be connected to the cable 30 by any suitable means, as described in more detail hereinafter.

In order to encapsulate the input comparison module 23 in such manner that the zero-offset and span adjustment transformers are completely encapsulated while at the same time providing an arrangement whereby the number of turns on these transformers may be varied after encapsulation to permit field adjustment to different offset and span requirements, the input comparison module 23 is cast in two steps with a front panel 64 being cast first as more fully illustrated in Figs. 9 to 16. Referring now to Figs. 9 to 16, there is provided a front panel die 65 open at its upper end or top and provided with a parting line 66 to form two die portions 67 and 68. The front panel die 65 additionally includes a moulding plate 71 which co-operates with the die portions 67 and 68 to close the bottom of the die 65 providing a trough shape for the panel die 65. The moulding plate 71 is provided with a plurality of apertures for mounting a plurality of electrical terminals 43 and fine span and fine zero-offset adjusting potentiometers 72 and 73, respectively.

In order to provide for positioning of a span transformer 75 and a zero or offset transformer 76 within the input comparison module 23, the respective transformers 75 and 76 are supported on arbors 77 and 78, respectively, extending through apertures 81 and 82 from one of the die portions 68. The transformers 75 and 76 are each of the toroidal type provided with a toroidal core on which the windings of the transformer are wound, these cores having the central axial openings 83 and 84, respectively, receiving the respective arbors 77 and 78. The transformers 75 and 76 are spaced from the moulding plate 71 a suitable distance so that a subsequent casting of the front panel 64 positions and partially embeds a portion of the toroid in the front panel, as illustrated in Fig. 13.

In order to provide a winding passage through the core of the transformers 75 and 76 the moulding plate 71 is provided with a pair of upwardly extending projections 85 spaced inwardly from the openings 83 and 84 in the respective transformers 75 and 76. Moreover, in order to provide a recess in the encapsulated unit 23 to receive externally wound turns of wire, the die portion 68 is provided with a pair of inwardly extending projections 86 aligned below the openings 83 and 84, respectively. With the components thus held in place by the front panel die 65, an encapsulating compound may then be poured into the die 65, the die 65 being positioned horizontally and the compound poured to a depth sufficient to engage and position its components.

With the front panel 64 thus poured, there is provided a front panel assembly 87 illustrated in Fig. 12. It will be seen that the front panel assembly 87 includes a plurality of terminals 43, the fine adjusting potentiometers 72 and 73, and the transformers 75 and 76. Moreover, the front panel 64 is provided with a pair of rectangular apertures 90 formed by the upwardly extending projections 85 and a pair of recesses 91 formed by the inwardly extending projections 86.

In order to complete the input comparison module 23, an electronic printed circuit board assembly 92, Fig. 13, is combined with the front panel assembly 87. The electronic assembly 92 includes a plurality of electronic components 93, such as capacitors, resistors,

transistors, and the like, mounted on respective sides of a printed circuit panel 94 of insulating material. Additionally, the mounting panel 94 is provided with a plurality of electrical terminals 43 described heretofore. The mounting panel 94 is provided with suitable electrical conductors of the printed circuit type so as to interrelate its respective electronic components 93 and terminals 43. Moreover, the components mounted on the front panel assembly 87 are connected with the electronic components 93 by conventional lead wires.

In order to encapsulate the electronic components including the front panel assembly 87 and the printed circuit board assembly 92, these assemblies are transferred to a mould 95 for final casting of the encapsulating compound. The mould 95 includes an angular mould body 96, as illustrated in Fig. 16, closed at its end, and which additionally includes a top and bottom mounting plate 97 and 98 and a centre plate 101. The top and bottom mounting plates are provided with apertures which respectively line up with selected ones of the electrical terminals 43 on the front panel assembly 87 and the electronic board assembly 92 accurately to position the front panel assembly 87 and the electronic board assembly 92 relative to each other. Mounting plates 97 are employed to hold the board assembly 92 and the panel assembly 87 in spaced relation during interconnection thereof as well as during the moulding process. Additionally, the centre plate 101 is provided with a plurality of apertures which align with additional ones of the electrical terminals 43 on the printed circuit board assembly 92. The top and bottom mounting plates 97 and 98 and the centre plate 101 are secured to the respective terminals 43 by appropriate aligning screws 102.

In order to provide for a passageway through the centre openings 83 and 84 of the span transformer 75 and the zero-offset transformer 76, the mould body 96 is provided with a pair of pins 103 extending inwardly through openings 83 and 84, respectively, and additionally provided with a pair of projections 104 extending inwardly to define recesses 91 in the front panel 64 and to extend the recesses 91 to the pins 103 thereby to provide a passageway through the centre of the toroidal transformers 75 and 76. Moreover, in order to complete the passageway around the transformers 75 and 76, rectangular casting bars 105 are positioned through the rectangular apertures 90 to engage the respective pins 103. The mould thus formed is provided with a casting cavity 106, Fig. 16, housing the electronic components of the input module 23. It will be noted that the front face 64 forms one side of the cavity 106. A sprue opening 107 communicates with the casting cavity 106 to provide for filling the cavity 106 with encapsulating compound. Once the input module components are encapsulated by a compound poured through the sprue opening 107, the mould components may be disassembled to eject an encapsulated input comparison module 23. It will be appreciated that the pins 103, projections 104, and casting bars 105 co-operate to form the passageways 110 and 111 through the centre openings 83 and 84 of the span transformer 75 and zero-offset transformer 76, respectively, as best illustrated in Figs. 17, 18 and 19. It will also be noted that while the passageways 110 and 111 permit field adjustment of the number of turns wound around the cores of the transformers, the transformers are themselves completely encapsulated.

In order to provide for inductive calibration of the instrument amplifier for various input spans and zero-offset levels, a span transformer secondary winding 112 is wound around the core of the span transformer 75 through the passageway 110, and a zero-offset transformer secondary winding 113 is wound around the core of the transformer 76 through the passageway 111. The number of turns in each of the windings 112 and 113 can be selected to meet required span and offset requirements, it being understood that each turn of these windings represents a predetermined increment of span or offset in millivolts. For example, in Fig. 17 the span transformer secondary winding 112 is provided with three turns and the zero transformer winding 113 is also provided with three turns. In Fig. 18 the transformer winding 112 is illustrated as having a greater number of turns.

It will be appreciated that the electrical terminals 43 serve the dual function of providing connection to external conductors and of locating and positioning the components with the casting mould. If desired, the electrical connections may be made between the encapsulated units and the conductors of the cable 30 may be completely sealed. One such embodiment is illustrated in Fig. 20 wherein an electrical terminal 114, which is similar to the electrical terminals 43, is additionally provided with sharp upwardly extending prongs 115. The electrical terminal 114 engages a flexible printed-circuit type cable 117, similar to the connector 30, which includes a plurality of electrical conductors enclosed between a pair of sheets of plastic or other insulating material 120 and 121. The cable 117 is provided with an aperture 122 aligned with the electrical terminal 114 for the reception of a fastener such as the screw 123. Threading of the screw 123 in a threaded inner opening 116 of the electrical terminal 114 is effective to cause the prongs 115 to pierce the lower insulating sheet 121 and make electrical engagement with the electrical conductor. As illustrated in Fig. 20, the screw 123 is made of plastic and, accordingly, is

effective completely to seal hermetically the terminal connection; however, the screw 123 may be of metal provided with a coating of plastic or other electrical insulating material on the outer surfaces of its head.

Various other arrangements may be used for fastening the flexible printed circuit cable to the electrical terminals of the encapsulated unit so that this unit may be quickly disconnected from the circuit for repair or replacement. For example, in Fig. 23 there is illustrated a flexible electrical cable 133 the printed circuit conductors of which are arranged to be connected to terminals 135 which are embedded in the encapsulated unit. The terminal 135 is provided with a threaded internal bore 136 having an enlarged bottom portion 137. A plurality of "banana plug" type connectors 138 are positioned on the flexible cable 133 at points corresponding to the terminals 135 so that the plug portion 139 of the connector 138 may be forced into the bore 137 to provide a snap fastener arrangement in which the printed circuit conductor 134 is held against the end face of the terminal 135 by the connector 138. It will be noted that the threaded bore 136 may be used to secure the terminal 135 to the mould during the encapsulating process.

Fig. 24 illustrates another connecting arrangement in which a flexible printed circuit cable 143 is secured to a composite terminal 144 by snap action means. More particularly, the terminal 144 includes a first member 145 similar to the electrical terminal 43 heretofore described in detail and additionally includes a second member in the form of a threaded plug 146 having a rounded head portion, the plug 146 being threaded into the member 145 after the encapsulating process has been completed. The cable 143 is provided with a snap button portion 147 having a complementary recess 148 for snapping over the projection 146 so that the printed circuit conductor 149 of the cable 143 is held against the end surface of the terminal 145. This arrangement also provides for the use of the threaded terminals during the moulding operation to position the components within the moulds while permitting quick detachable connection of the modules both together and to external circuits.

Reference is made to co-pending application No. 29,354 of 1966 (Serial No. 1052053) which is divided out of this application.

Reference is also made to co-pending application No. 32,562 of 1966 (Serial No. 1052054) which is divided out of this application.

WHAT WE CLAIM IS:—

1. An encapsulated electrical unit, comprising an assembly of electrical components including at least one winding of a transformer, a compound encapsulating said components into a sealed unit, and a plurality of electrical terminals accessible from the exterior of the encapsulated unit and connected to selected ones of said components, at least two of said terminals being adapted to receive a further winding for said transformer, said unit being provided with a passageway extending through the inductive circuit of said one winding to provide for the winding of a selected number of turns of wire forming said further winding.

2. An electrical unit according to claim 1, including two said transformers the said one winding of each of which is toroidally wound around an aperture which constitutes a said passageway.

3. An electrial unit according to claim 2, wherein a predetermined number of turns of wire are wound through the said passageway through the inductive circuit of the said one winding of one said transformer which wire has its two ends respectively connected to a first pair of said terminals, and wherein a predetermined number of turns of further wire are wound through the said passageway through the said one winding of the other said transformer which further wire has its two ends respectively connected to a second pair of said terminals.

4. An electrical unit according to claim 3 for use in an instrument amplifier wherein an output signal to a recorder is produced as a function of an input signal from a measuring device, in which one said transformer is a span-adjustment transformer the number of turns of wire forming the said further winding of which determines the relationship between the range of the said input signal and the range of the said output signal, and in which the other of said transformers is a zero-offset adjustment transformer the number of turns of wire forming the said further winding of which determines the value of the said signal corresponding to the minimum said output signal in a given range.

5. An electrical unit according to any preceeding claim having at least some of its said terminals connected to the terminals of at least one other encapsulated electrical unit by a flexible electrical connector comprising a plurality of electrical conductors insulated from each other, selected ones of said terminals of said electrical units being electrically connected to each said electrical conductor whereby electrically to interconnect the electrical units in a predetermined manner.

6. An electrical unit according to claim 5, in which the said flexible connector is sheet-like and is provided with printed circuit-type conductors.

7. An electrical unit according to claim 5, in which said flexible connector is sheet-like and in which the said electrical conductors are embedded in insulating material.

8. An electrical unit according to any one of claims 5 to 7, including sealing means for providing a seal between the said flexible electical connector and the said encapsulated electrical units.

9. An electrical unit according to any one of claims 5 to 8, in which the electrical connections between each said terminal and a said electrical conductor are readily releasable.

10. An electrical unit according to claim 9, in which each said terminal is electrically connected to a said electrical conductor by means of a screwed connection.

11. An electrical unit according to claim 10, in which each said terminal includes at least one projecting spike arranged to be forced into engagement with the said electrical conductor by the said screwed connection so as electrically to connect the said terminal to the electrical conductor.

12. An electrical unit according to any of claims 5 to 9, in which each said terminal defines a narrow bore opening into a larger recess, and in which each said electrical conductor is provided with a plurality of resilient connectors each of which has a portion deformable to permit it to pass through the said narrow bore of a said terminal into the said recess where it resiles to hold the said terminal in electrical connection with the said electrical conductor.

13. An electrical unit according to any one of claims 5 to 9, in which the said flexible electrical connector includes insulating material provided with deformable resilient portions for respectively engaging and locating on portions of said first terminals whereby to hold each said terminal in electrical connection with the said electrical conductor.

14. A method of forming an encapsulated electrical unit, comprising the steps of mounting an assembly of electrical components, including at least one winding of a transformer, on a mounting panel, placing said mounting panel with said electrical components thereon in a mould including at least one member positioned to extend through the inductive circuit of said one winding of said transformer, admitting encapsulating compound into said mould to encapsulate said components so as to form the encapsulated electrical unit, and removing said mould and said member from said encapsulated electrical unit, whereby the encapsulated electrical unit has a passageway formed through the inductive circuit of said one winding by the presence of the said member during the encapsulating step which passageway permits the winding of turns of wire forming a further winding for the transformer.

15. A method according to claim 14, in which the said mounting panel forms a closure for said mould when said mounting panel is placed in said mould.

16. An encapsulated electrical unit, substantially as described with reference to Figures 1 and 9 to 19 of the accompanying drawings.

17. A method of forming an encapsulated electrical unit, substantially as described with reference to Figures 1 and 9 to 19 of the accompanying drawings.

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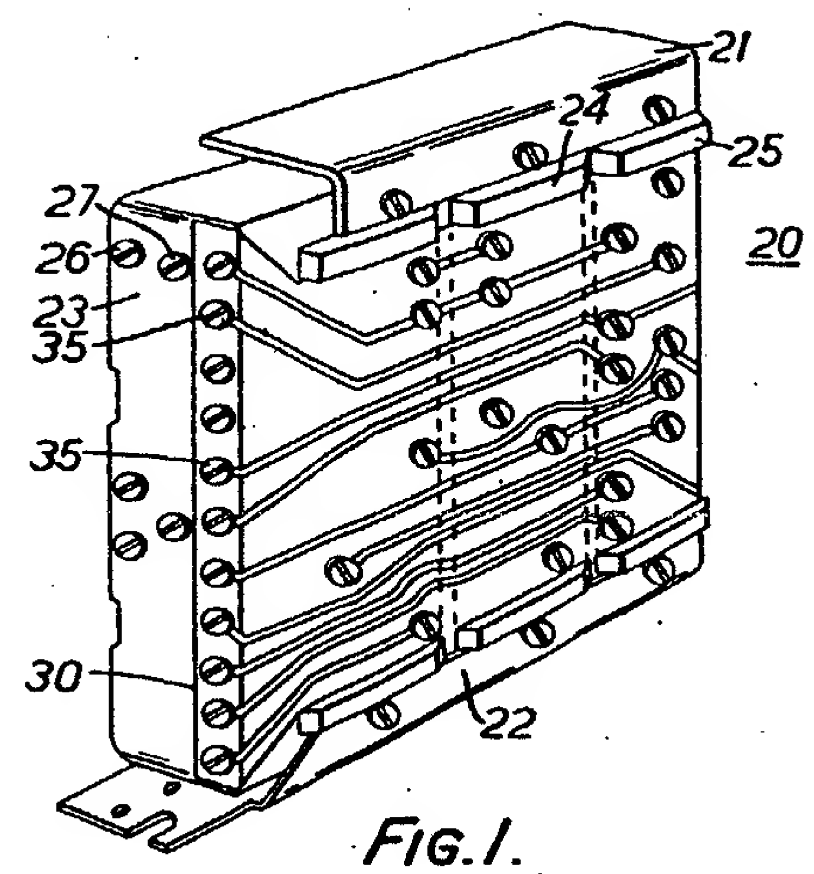

FIG. 1.

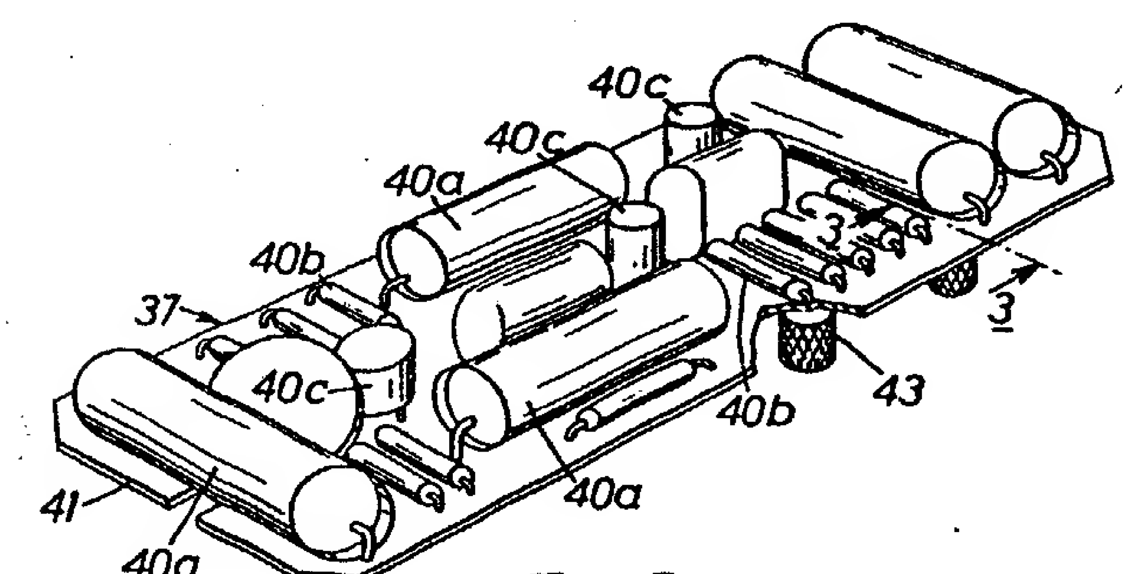

FIG. 2.

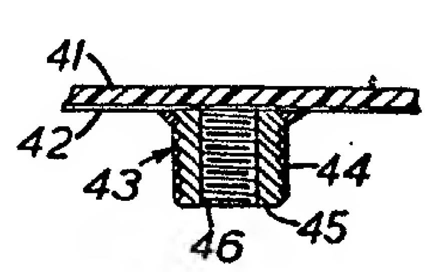

FIG. 3.

1052052 COMPLETE SPECIFICATION

5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 2 & 3

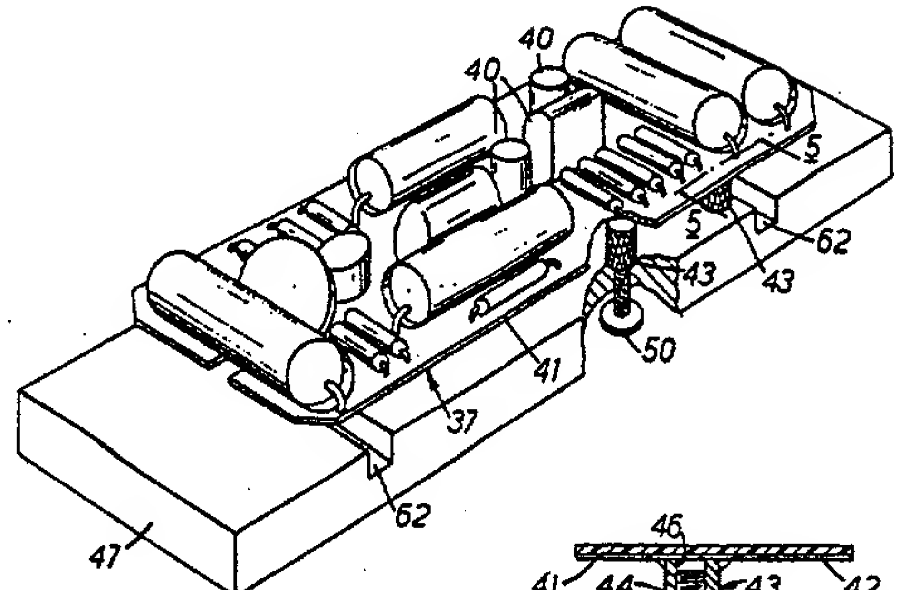

FIG. 4.

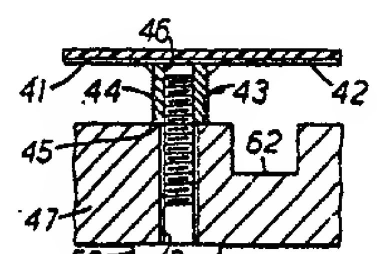

FIG. 5.

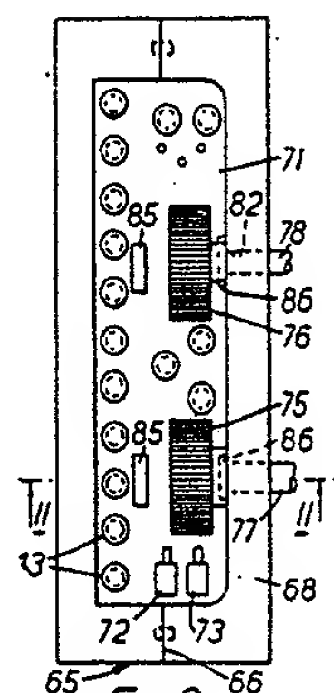

FIG. 9.

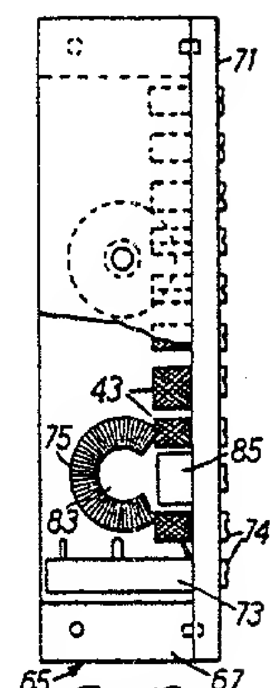

FIG. 10.

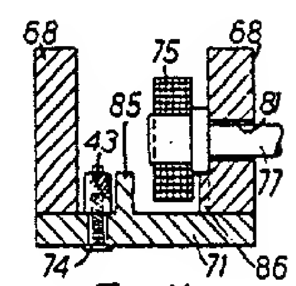

FIG. 11.

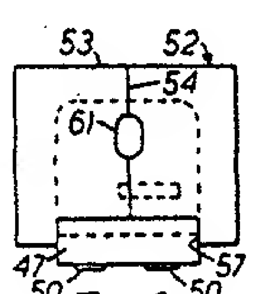

FIG. 6.

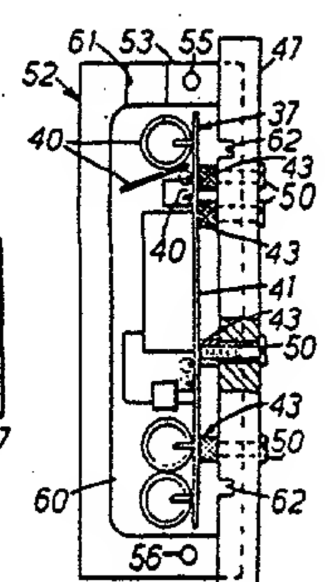

FIG. 7

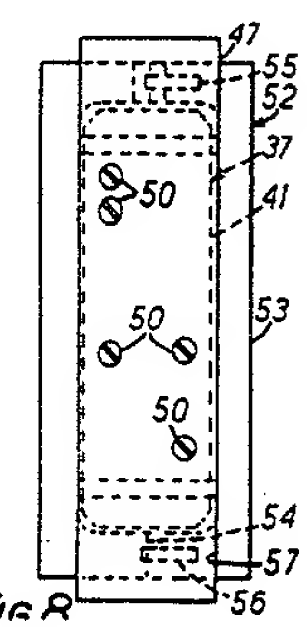

FIG. 8

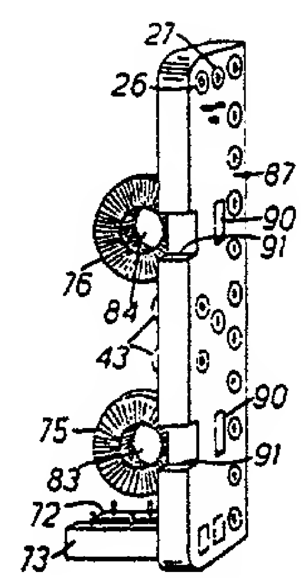

FIG. 12

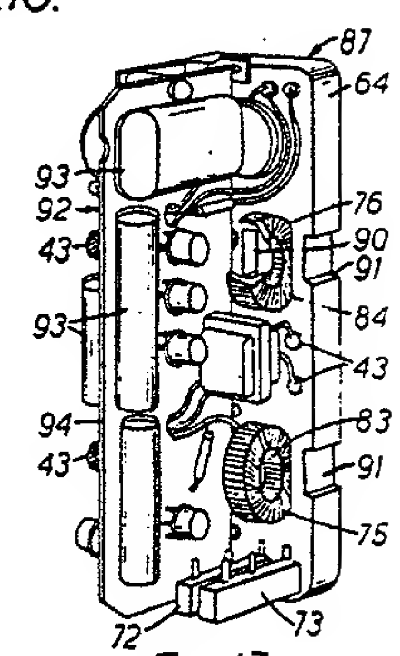

FIG. 13

1052052 COMPLETE SPECIFICATION
5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 4 & 5

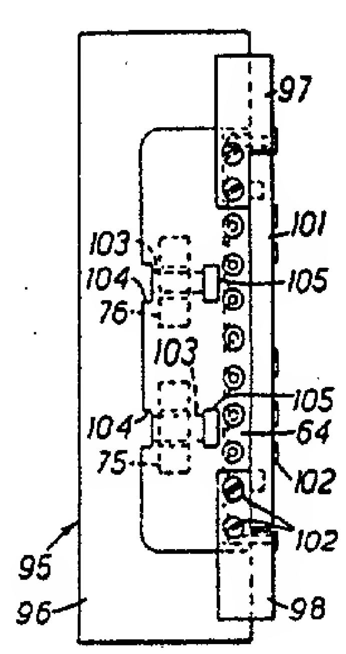

FIG. 14.

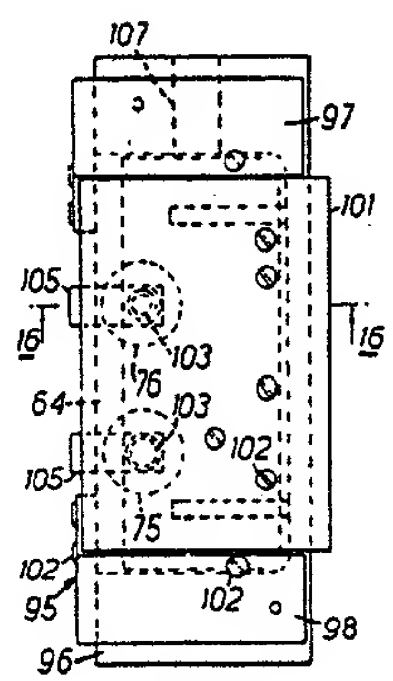

FIG. 15.

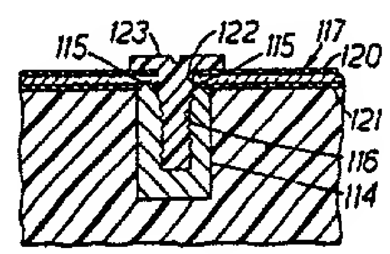

FIG. 20.

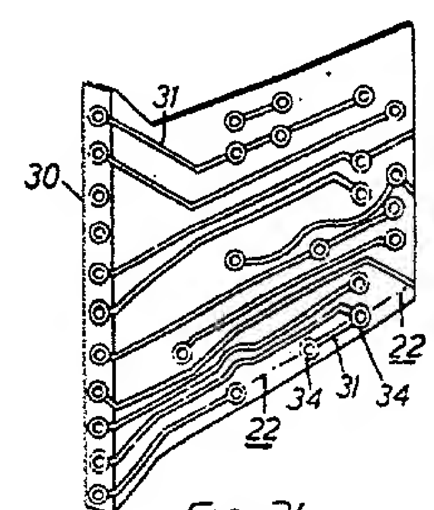

FIG. 21.

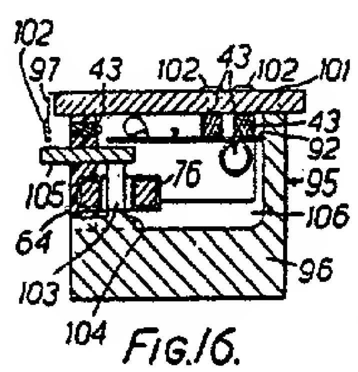

FIG. 16.

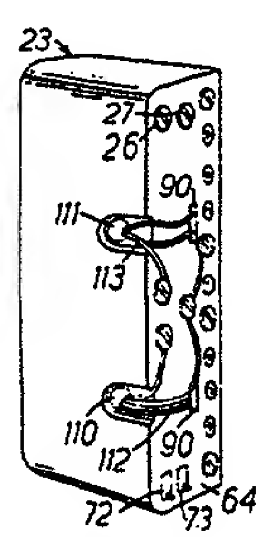

FIG. 17.

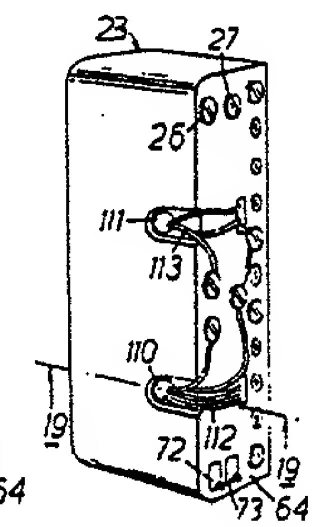

FIG. 18.

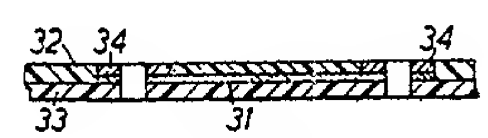

FIG. 22.

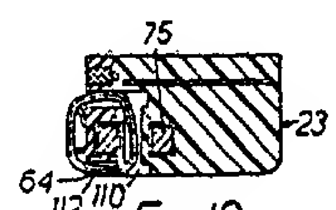

FIG. 19.

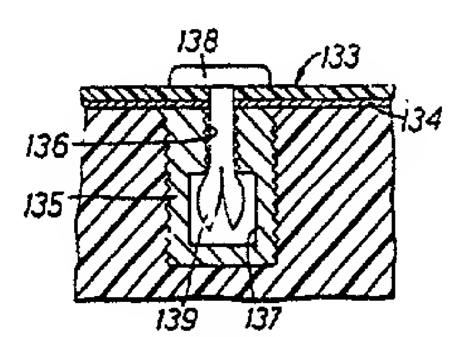

FIG. 23.

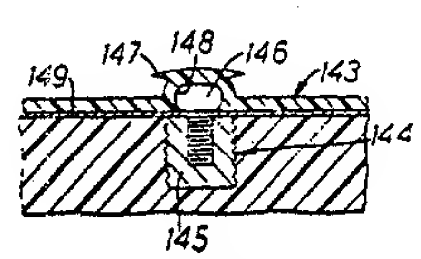

FIG. 24.